Electronic Services - Los Angeles
M11569X

Earth resistance tests with

Three Point

vibroground®

Model 251
Model 255

MP MASTER
MA30050

MOD 255

MANUAL 18507

ASSOCIATED RESEARCH, INC.
3758 W. BELMONT AVE., CHICAGO, IL. 60618 • (312) 267-4040

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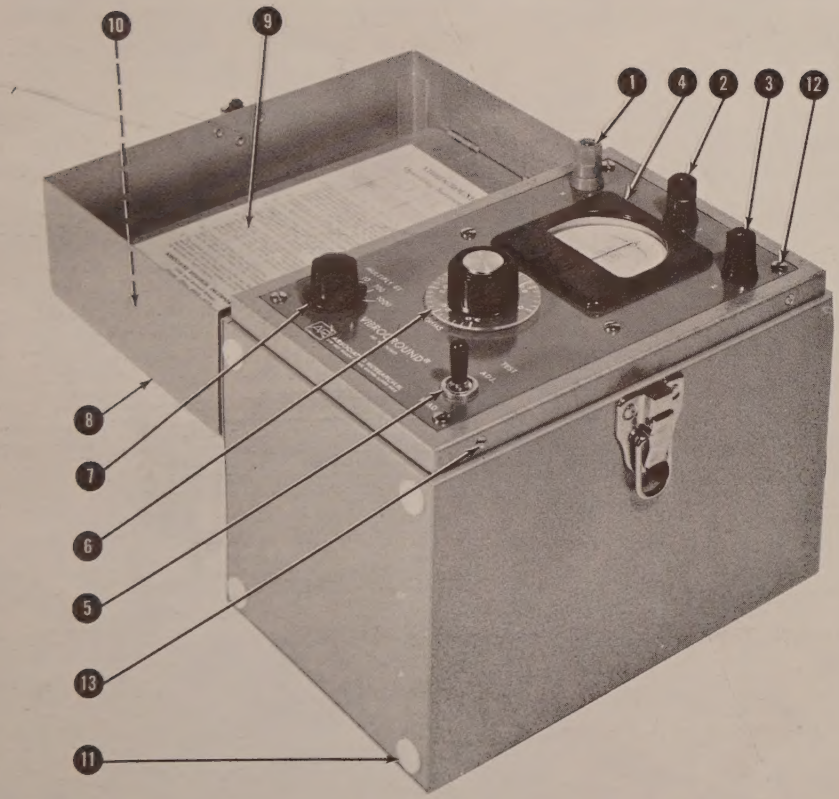
Lift flap for figure 1

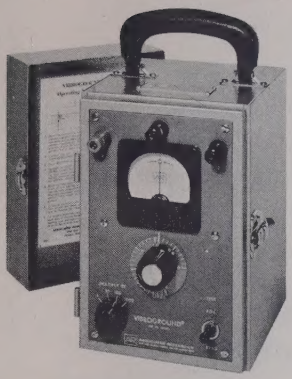


1. Terminal X (Grounding Electrode)
2. Terminal 1 (Auxiliary Potential Electrode)
3. Terminal 2 (Auxiliary Current Electrode)
4. Galvanometer
5. TEST Switch
6. Meter Balancing Control and OHMS Indicator
7. Range (MULTIPLY BY) Switch
8. Cover and Storage Compartment
9. Instruction Card
10. Accessory Cover Latch
11. Plastic Feet (8)
12. Front Panel Screws (4)
13. Battery Compartment Screws (4)

Figure 1. Three Point VIBROGROUND

Figure 2. Field Use of the Three Point VIBROGROUND

263A.
$300.00



Earth resistance tests with

Three Point

vibroground

This handbook covers the operation, application, and service instructions applicable to three point VIBROGROUNDS. These instruments are self-contained battery powered units, which are employed for the measurement of resistance of "man-made" Grounding Systems.

The **Model 251 VIBROGROUND®** has three ranges, 0-12 ohms, 0-120 ohms, and 0-1200 ohms, while the **Model 255 VIBROGROUND®** has four ranges, 0-3, 0-30, 0-300, and 0-3000 ohms.

These VIBROGROUND'S are manufactured by Associated Research, Inc., 3758 West Belmont Avenue, Chicago, Illinois 60618.

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WARNING

It should be impressed on all test personnel that a lethal potential can exist between the station ground and a remote ground if a system fault involving the station ground occurs while ground tests are being made. Since one of the objects of tests on a station is the establishment of the location of an effectively remote point for both current and potential electrodes, the leads to these electrodes must be treated as though a possible potential could exist between these test leads and any point on the station ground grid.

SAFETY PRECAUTIONS WHILE MAKING GROUND TESTS

The use of rubber gloves and other protective devices is recommended. At no time should the hands or other parts of the body be allowed to complete a path between points of possible high potential difference. The safety procedures and practices of your cognizant organization should be strictly followed.

The Ground Grid of a large station will usually have a resistance to earth of about 0.08 ohm. With a ground fault current of 5000 amperes, the potential to a remote point would be 400 volts. This value should be taken as the minimum to be expected when working with any grounding system.

DESCRIPTION AND GENERAL FEATURES OF THE VIBROGROUND

DESCRIPTION

VIBROGROUND is the fast, accurate way to test man-made grounds for electrical and electronic systems. Ground resistance measurements made with the VIBROGROUND are direct reading and require no computations.

CONSTRUCTION

This instrument is housed in a welded steel case with a carrying handle and removable cover (see figure 1). Its synchronous vibrator power supply operates on self-contained batteries. No cranking or leveling is required.

TERMINALS X, 1 AND 2

Terminals X, 1 and 2 connect the VIBROGROUND to the Grounding Electrode and the auxiliary reference. Terminal X is connected to the Grounding Electrode (the point under test) through a suitable* connecting lead. Terminals 1 and 2 are connected respectively to the auxiliary potential and current reference electrodes.

GALVANOMETER

The galvanometer with its zero center scale indicates when the measuring system of the VIBROGROUND is in balance with the Grounding Electrode resistance. During the process of balancing, the galvanometer pointer indicates to the left or right of center scale, depending on whether the resistance of the Grounding Electrode is high or low with respect to the VIBROGROUND measuring system.

OHMS SCALE AND METER BALANCING CONTROL

The meter balancing control provides a means of adjusting the VIBROGROUND measuring circuit to obtain balance as indicated by the galvanometer.

The OHMS indicator scale is calibrated to indicate the resistance to earth of the Grounding Electrode. When balance is achieved, the resistance of the Grounding Electrode is read on the OHMS indicator scale at a point adjacent the index mark.

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*The test lead connecting the Grounding Electrode to terminal X should be kept as short as possible since this is a common lead for the current supply and one end of the measuring circuit. Its total resistance should not exceed 0.05 ohm. The resistance of the VIBROGROUND test lead connecting the auxiliary potential electrode to terminal 1 has no bearing on accuracy. The resistance of the test lead connecting the auxiliary current electrode to terminal 2 has no bearing on accuracy but should not exceed 1 ohm to minimize power loss in the lead when measuring in the 1 to 5 ohm range. Ideally, all power should be dissipated in the earth and not in the test lead.

RANGE SELECTOR SWITCH (MULTIPLY BY)

The range selector switch provides multiplying factors for measuring a wide variety of Grounding Electrode resistances.

TEST SWITCH

The three-position TEST switch energizes the power supply during the balancing operation. The switch is spring-returned to the center (off) position. During initial balancing, the switch is set to the ADJ position to de-sensitize the galvanometer and thereby prevent mechanical damage to the galvanometer should the measuring system be greatly unbalanced. Once the galvanometer pointer has been adjusted to near zero center, the switch is set to the READ position for maximum sensitivity during final balancing.

USE OF THE VIBROGROUND

Earth ground is commonly used as an electrical conductor for system returns. Although resistivity of the earth is high compared to a metal conductor, overall resistance can be quite low because of the large cross-sectional area of the electrical path.

Connections to earth are made with devices such as Grounding Electrodes, Ground Grids, and Ground Mats. (See Glossary.) The resistance to earth of these devices varies proportionately with earth resistivity (see Glossary), which in turn depends on the composition, compactness, temperature, and moisture content of the soil.

A good grounding system limits system-to-ground resistance to an acceptably low value. This protects personnel from a dangerously high voltage during a fault in the equipment. Furthermore, equipment damage can be circumvented by using this ground current to operate protective devices.

VIBROGROUND testing measures the Ground Resistance of a Grounding Electrode or Ground Grid system. Some of the major purposes of VIBROGROUND testing are to verify the adequacy of a new grounding system, detect changes in an existing system, and determine the presence of hazardous Step Voltage and Touch Voltage.

In addition to personnel safety considerations, VIBROGROUND testing also provides information for equipment insulation ratings. Equipment can be damaged by an overvoltage that exceeds the rating of the insulation system.

Figure 3 depicts a poorly grounded system where Ground Resistance (R) is 10 ohms. Assuming a power source impedance (Z) of 40 ohms, a short circuit between the 5000-volt power line and the steel tower would produce 100 amperes of short-circuit current (I)!

$$I = \frac{E}{Z + R} = \frac{5000}{40 + 10} = 100 \text{ Amperes of short-circuit current}$$

A person touching the tower would be subjected to the voltage (E') developed across the Ground Resistance:

$$E' = IR = 100 \times 10 = 1000 \text{ volts between tower and ground}$$

Statistics vary widely concerning what may be considered a dangerous voltage. This depends largely on body resistance and other conditions. However to limit the Touch Voltage for this situation to, say, 100 volts, the Ground Resistance for the tower would have to be less than one ohm.

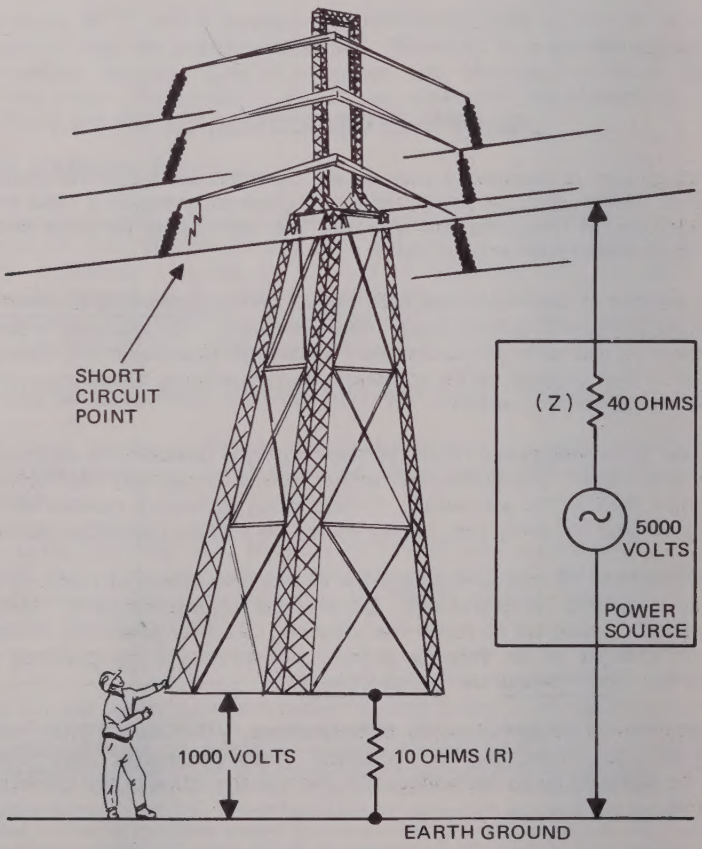


Figure 3. Poorly Grounded System

HOW THE VIBROGROUND WORKS

Several methods are used for measuring the resistance to earth of a Grounding Electrode. One of the most universally employed is that used in the VIBROGROUND – the fall-of-potential method (figure 4).

In this method, auxiliary electrodes 1 and 2 are placed at sufficient distances from Grounding Electrode X. A current (I) is passed through the earth between the Grounding Electrode X and Auxiliary Current Electrode 2 and is measured by the ammeter. Voltage drop (E) between the Grounding Electrode X and Auxiliary Potential Electrode 1 is indicated on the voltmeter. Resistance (R) can therefore be calculated:

$$R = \frac{E}{I}$$

Certain problems arise in measuring with the simple system of figure 4, as follows:

1. Natural currents in the soil caused by electrolytic action. These cause the voltmeter to read either high or low, depending on polarity.
2. Induced currents in the soil, instrument, or electrical leads. These may cause vibration of the meter pointer, interfering with readability.
3. Resistance in the auxiliary electrode and in the electrical leads. These introduce error into the voltmeter reading.

Because of special circuit design, the VIBROGROUND is not subject to any of these problems.

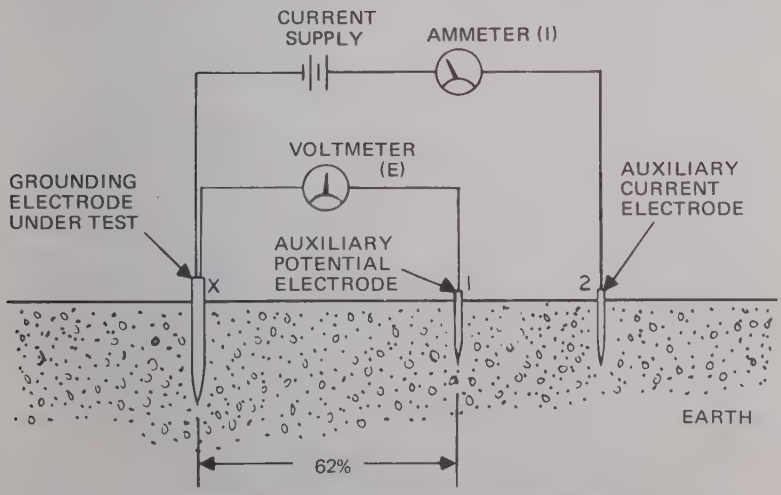


Figure 4. Fall-of-Potential Method of Testing

The VIBROGROUND uses a null balance metering system. Unlike the separate voltmeter and ammeter method, this instrument provides a read-out directly in ohms, thus eliminating calculation. Although the integrated systems of the VIBROGROUND are sophisticated, they still perform the basic functions for fall-of-potential testing.

CURRENT SUPPLY

As in the simple circuit of figure 4, the VIBROGROUND also has a current supply circuit. (See figure 5.) This may be traced from Grounding Electrode X through terminal X, potentiometer R1, the secondary of power transformer T1, terminal 2, and auxiliary current electrode 2. This produces a current in the earth between electrodes X and 2.

When switch S1 is closed, battery B energizes the coil of vibrator V. Vibrator reed V1 begins oscillating, thereby producing an alternating current in the primary and secondary windings of T1. The negative battery terminal is connected alternately across first one and then the other half of the primary winding.

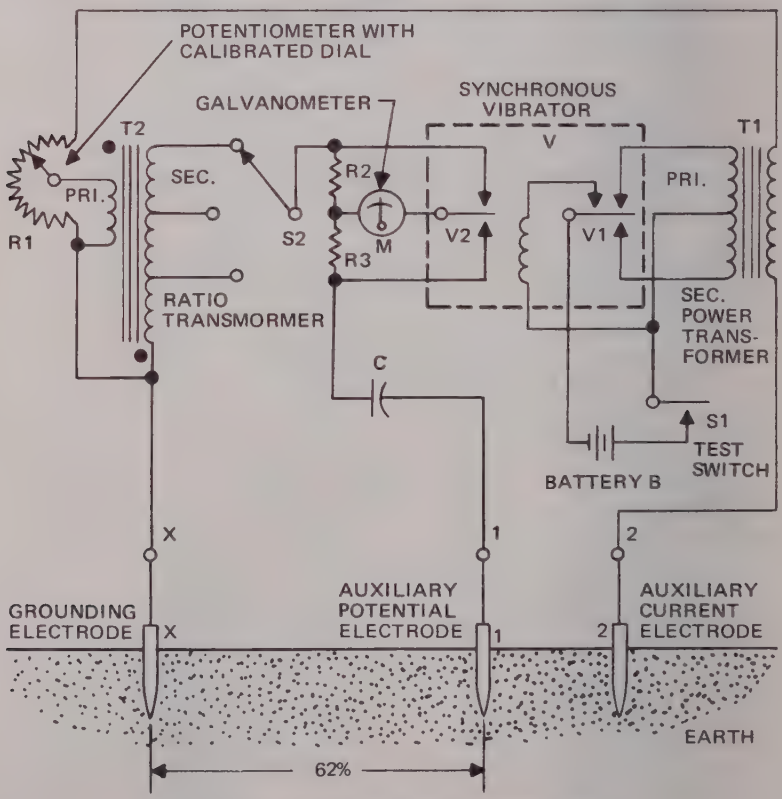


Figure 5. VIBROGROUND Circuit

VOLTMETER CIRCUIT

The voltmeter circuit can be traced from Grounding Electrode X through terminal X, the T2 secondary, switch S2, resistors R2 and R3 (Paralled by the meter and V2 contacts), capacitor C, terminal 1, and auxiliary potential electrode 1.

The current in the earth between Grounding Electrode X and auxiliary current electrode 2 creates a voltage drop due to the earth's resistance. With auxiliary potential electrode 1 placed at any distance between Grounding Electrode X and auxiliary current electrode 2, the voltage drop causes a current in the voltmeter circuit through balanced resistors R2 and R3. The voltage drop across these resistors causes galvanometer M to deflect from zero center scale.

Vibrator reed V2 operates at the same frequency as V1, thereby functioning as a mechanical rectifier for galvanometer M. The vibrator is tuned to operate at 97.5 Hertz, a frequency unrelated to commercial power line frequencies and their harmonics. Thus, currents induced in the earth by power lines are rejected by the VIBROGROUND and have virtually no effect on accuracy. Stray direct current in the earth is blocked out of the voltmeter circuit by capacitor C.

The current in the primary of T2 can be adjusted with potentiometer R1. Primary current in T2 induces a voltage in the secondary of T2 which is opposite in polarity to the voltage drop caused by current in the voltmeter circuit.

With R1 adjusted so the primary and opposing secondary voltages of T2 are equal, current in the voltmeter circuit is zero and the galvanometer reads zero. The resistance of Grounding Electrode X can then be read on the calibrated dial of the potentiometer.

With no current in the voltmeter circuit, the lead resistance of the auxiliary potential electrode 1 has no bearing on accuracy. (With no current, there is no voltage drop in the leads.) Resistance to earth of the current electrode results only in a reduction of current and consequently a loss of sensitivity. Therefore, the auxiliary electrodes need only be inserted into the earth six to eight inches to make sufficient contact. In some locations where the soil is very dry, it may be necessary to pour water around the current electrode to lower the resistance to a practical usable value.

NATURE OF EARTH ELECTRODE RESISTANCE

Current in a grounding system is primarily determined by the voltage and impedance of the electrical equipment. However, the resistance of the grounding system is very important in determining the voltage rise between the Ground Electrode and the earth as well as the voltage gradients that will occur in the vicinity when current is present.

Three components constitute the resistance of a grounding system.

(1) Resistance of the conductor connecting to the Ground Electrode.

(2) Contact resistance between the Ground Electrode and the soil.

(3) Resistance of the body of earth immediately surrounding the electrode.

Resistance of the connecting conductor can be dealt with separately since this is a function of the conductor cross-sectional area and length. Contact resistance usually is negligibly small if the electrode is free from paint or grease. Therefore, the main resistance is that of the body of earth immediately surrounding the electrode.

Current from a Grounding Electrode flows in all directions via the surrounding earth. It can be considered that the current flows through a series of concentric spherical shells, all of equal thickness. (See figure 6.)

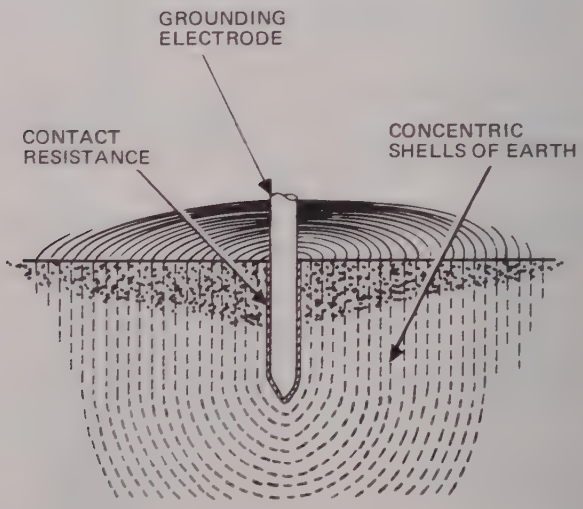


Figure 6. Concentric Spherical Shells

The shell immediately surrounding the electrode has the smallest cross-sectional area, therefore its resistance is highest. As the distance from the electrode is increased, each shell becomes correspondingly larger in cross-section, thus the resistance becomes smaller. Finally, a distance from the electrode is reached where additional shells do not add significantly to the total resistance. From a theoretical viewpoint, total resistance is included only when the distance is infinite. For practical purposes, only that volume which contributes the major part of the resistance need be considered. This is the Effective Resistance Area and depends on electrode diameter and driven depth.

The curve of figure 7 shows resistance in ohms of various diameter ground rods versus driven depth in feet. It will be noted that the relation of resistance to depth is not a linear function. Instead, the greater the depth, the less the resistance changes. This particular curve is based on homogeneous earth having a resistivity of 10,000 ohms per cubic centimeter, the formula for which is as follows.

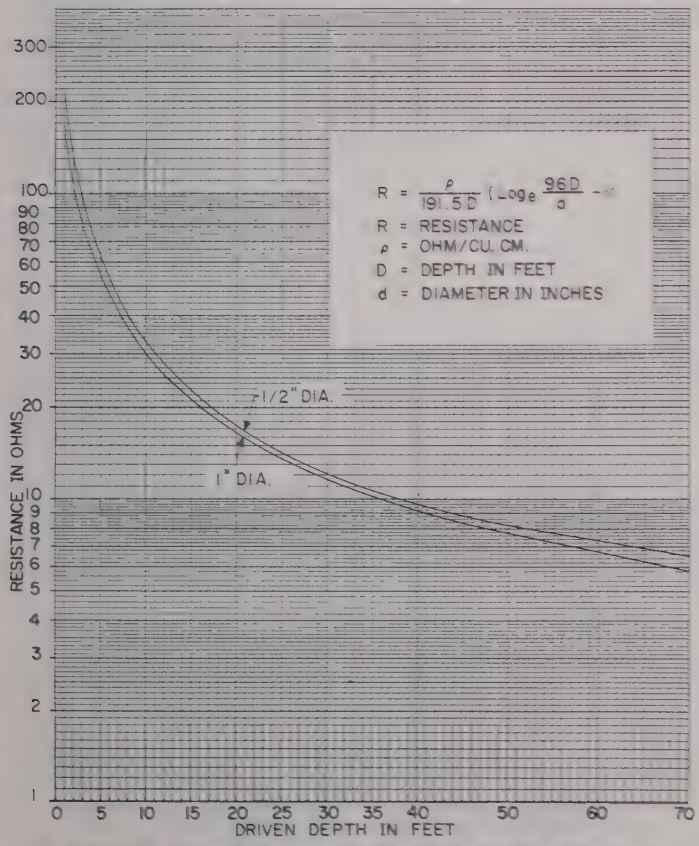


Figure 7. Ground Resistance Versus Ground Rod Depth

$$R = \frac{\rho}{191.5D} (\text{Log}_e \frac{96D}{d} - 1)$$

Where: R = Resistance

D = Depth in feet

d = Diameter in inches

ρ = Resistivity in ohms/cu cm

The Effective Resistance Area of a Grounding Electrode can also be expressed as the effective radius of a cross-section of earth. Determining this radius can be simplified if the electrode is theoretically replaced by its equivalent hemisphere. The resistance of a hemisphere buried below the surface is:

$$R = \frac{\rho}{2\pi r}$$

Where: R = Resistance of the hemisphere.

ρ = Resistivity of the surrounding earth.

r = Radius of the equivalent hemisphere.

The radius of an equivalent hemisphere can be determined according to figure 8, and as follows:

$$r = \frac{D}{\log_e \frac{96D}{d} - 1}$$

Where: r = Radius in feet

D = Depth in feet

d = Diameter in inches

The total resistance of a Grounding Electrode for a given distance from the electrode is expressed, for homogeneous soil, by:

$$R = \frac{\rho}{2\pi} \left(\frac{1}{r} - \frac{1}{r_1}\right)$$

Where: R = Effective total resistance

ρ = Resistivity of soil

r = Radius of equivalent hemisphere

r_1 = Distance from electrode

Without the use of complex formulae however, the resistance cannot be predicted for all types of soil, particularly since homogeneous soils are very rare and resistivity changes nonlinearly with depth.

Figure 8 is used in establishing the initial locations of the Auxiliary Current Electrode and the Auxiliary Potential Electrode, as will be seen later.

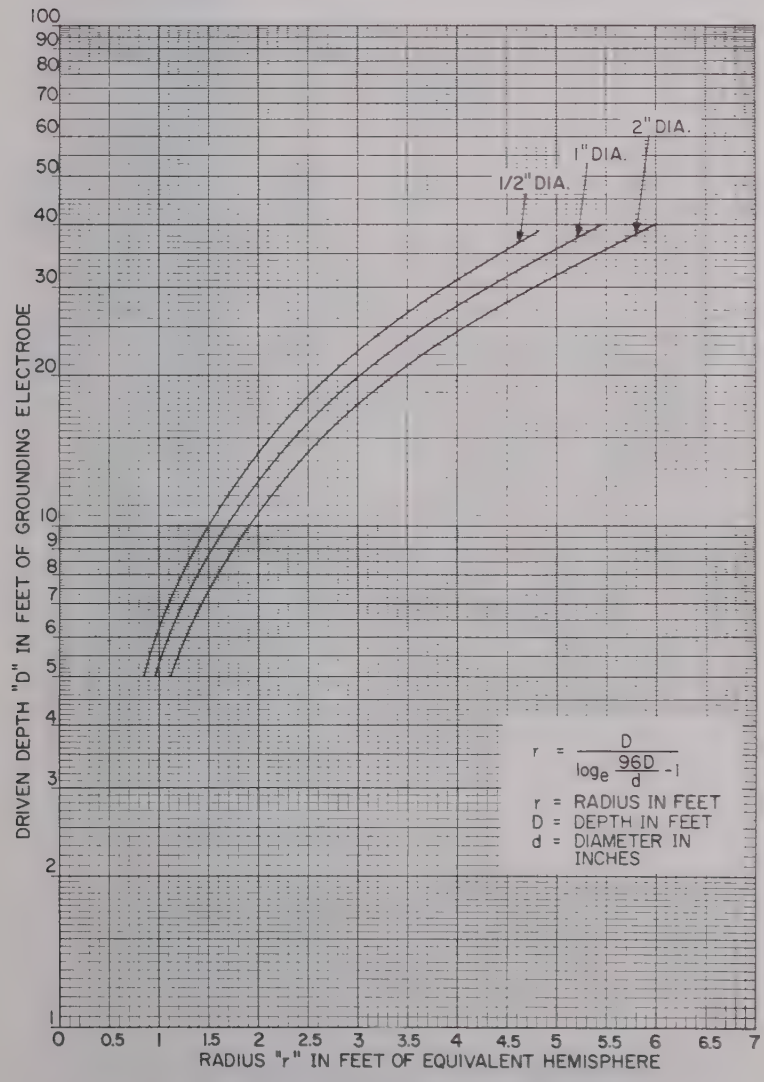

DRIVEN DEPTH "D" IN FEET OF GROUNDING ELECTRODE
RADIUS "r" IN FEET OF EQUIVALENT HEMISPHERE
1/2" DIA.
1" DIA.
2" DIA.
r = D / log_e (96D/d - 1)
r = RADIUS IN FEET
D = DEPTH IN FEET
d = DIAMETER IN INCHES

Figure 8. Ground Rod Depth Versus Equivalent Hemisphere Radii

VIBROGROUND TESTING PROCEDURE

GENERAL

To measure resistance of a Grounding Electrode with the VIBRO-GROUND an Auxiliary Current Electrode and an Auxiliary Potential Electrode are required. (See figures 5, 9 and 10.) The Current Electrode is placed a suitable distance from the Grounding Electrode under test, and the Potential Electrode is then placed at 62%* of the current electrode distance.

If the Current Electrode is too near the Grounding Electrode, their Effective Resistance Areas will overlap, as shown in figure 9. If a series of measurements are made with the Potential Electrode driven at various distances in a straight line between the Current Electrode and Grounding Electrode, the readings will yield a curve as illustrated in figure 9.

In figure 10 a curve is plotted with the Current Electrode at a sufficient distance from the Grounding Electrode. Note that the curve is relatively flat between points B and C, which are usually considered to be at least plus and minus 10 feet with respect to the 62% point. Usually a tolerance is established for the maximum allowable deviation for the second and third reading with relation to the initial reading at 62%. This tolerance is a certain $\pm$ percent of the initial reading, such as $\pm$ 1%, $\pm$ 2%, etc.

No definite distance for the current electrode can be forecast since the optimum distance is based on homogeneity of the earth, depth of the Grounding Electrode, diameter, etc. However, for a starting point for a single driven Grounding Electrode, the effective radius of the equivalent hemisphere can be computed or taken from figure 8 for homogeneous soil. The curve of figure 11 can then be used for initial placement of the auxiliary electrodes. Using the practical method of moving the Auxiliary Potential Electrode 10 feet either side of the 62% point, a curve can be plotted to determine if the current electrode spacing is adequate, as depicted by the curve flattening out between points B and C in figure 10.

*This 62% figure has been arrived at by empirical data gathered by many authorities on ground resistance measurement, and in some cases has been computed, based on an analysis of an equivalent hemisphere.

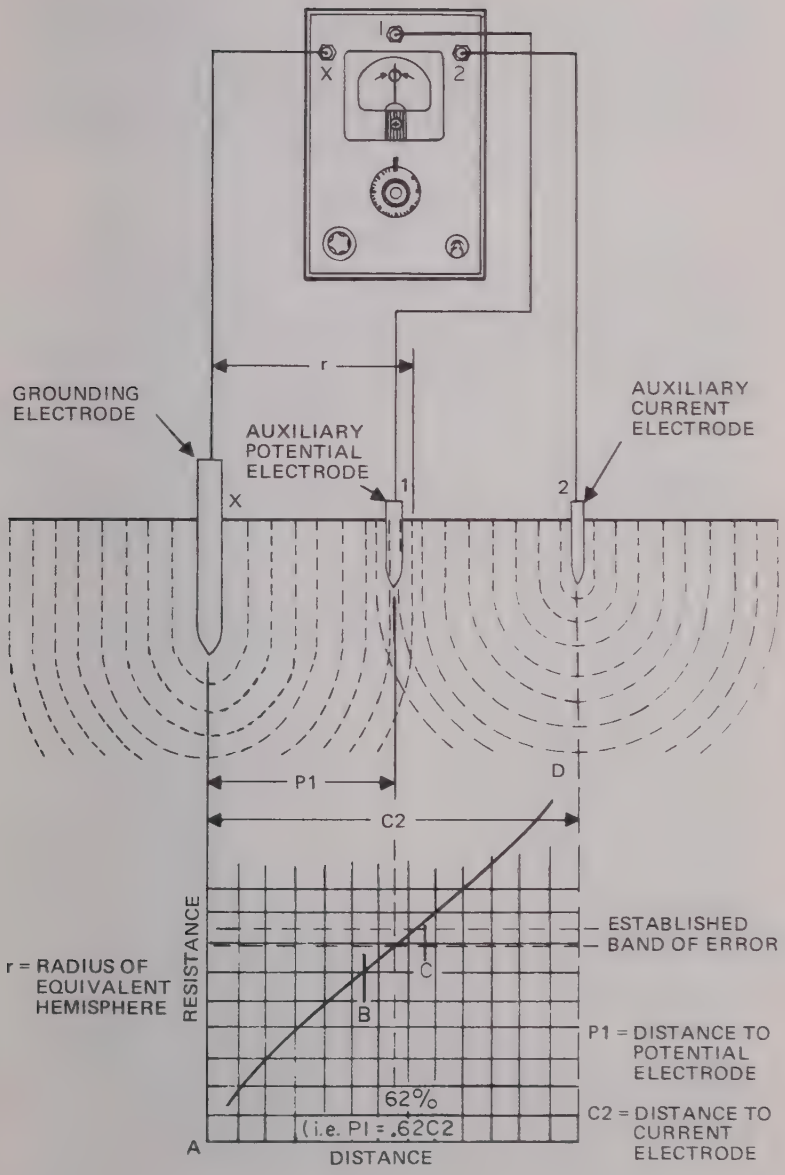


Figure 9. Plotted Curve Showing Insufficient Electrode Spacing

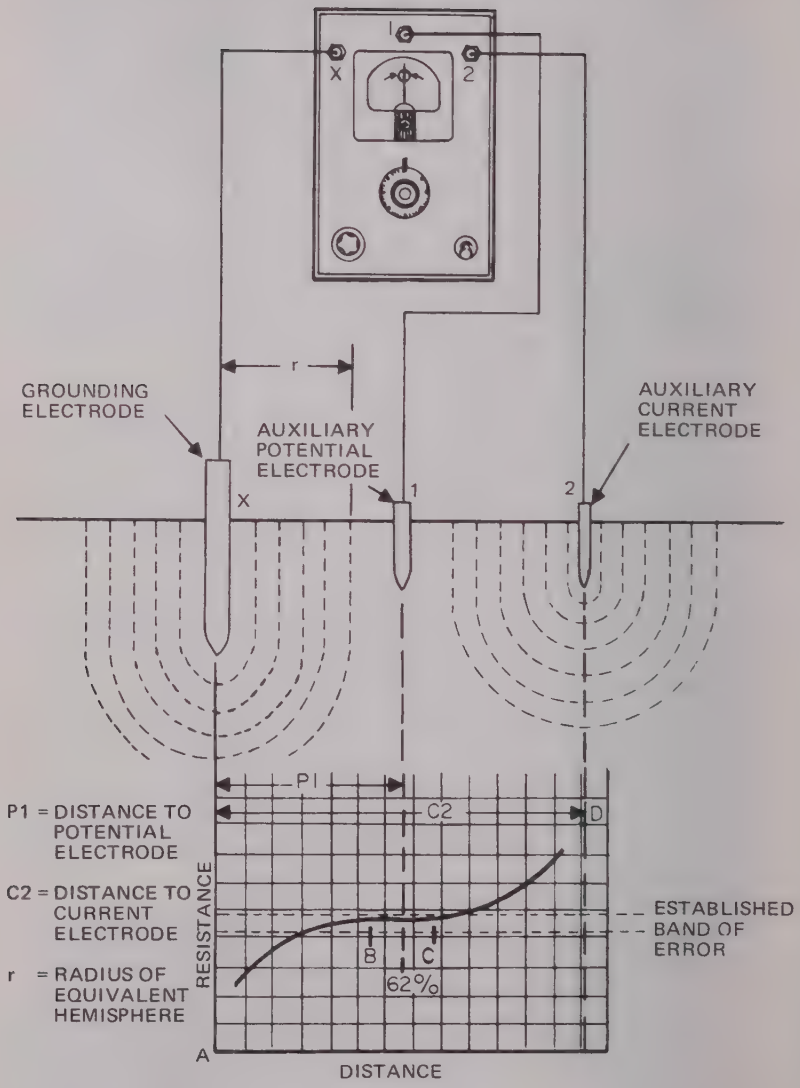


Figure 10. Plotted Curve Showing Adequate Electrode Spacing

For example, assume a 1-inch diameter Grounding Electrode, 10 feet deep. The equivalent hemisphere radius is 1.7 feet according to figure 8. Using figure 11, the current electrode would be established at approximately 90 feet and the potential electrode at approximately 55 feet for the initial reading. The results obtained when the potential electrode is moved (to 45 feet and then to 65 feet) will determine if the Current Electrode and consequently the Potential Electrode must be spaced at a greater distance.

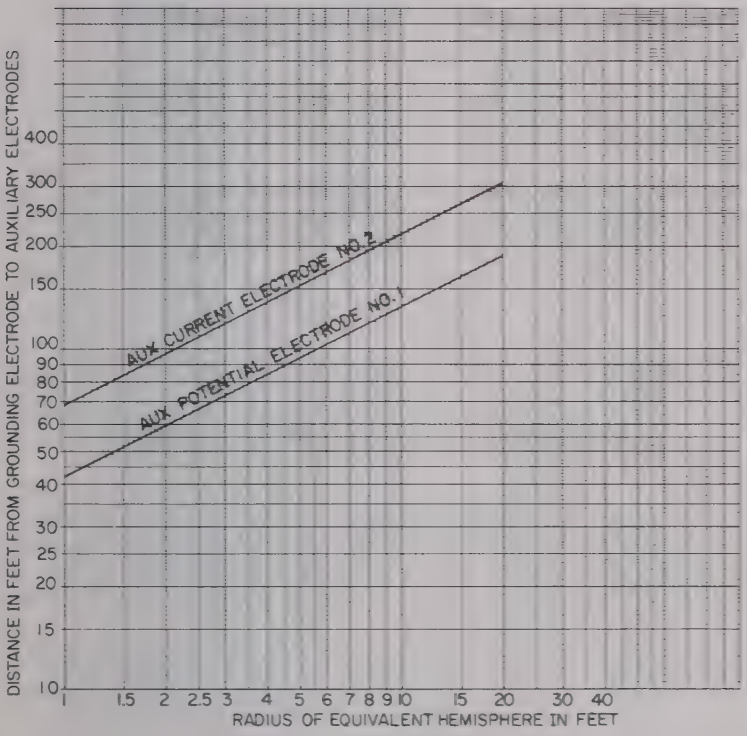


Figure 11. Auxiliary Electrode Distances Versus Equivalent Hemisphere Radii

It is usually advisable to plot a complete curve (figure 12) for each season of the year. These curves should be retained for comparison purposes. Measurements at established intervals in the future need only be made at the 62% point and, if desired, 10 feet on each side, providing there is no erratic deviation from the original curve. Serious deviation, other than seasonal, could mean corrosion has eaten away some of the electrode.

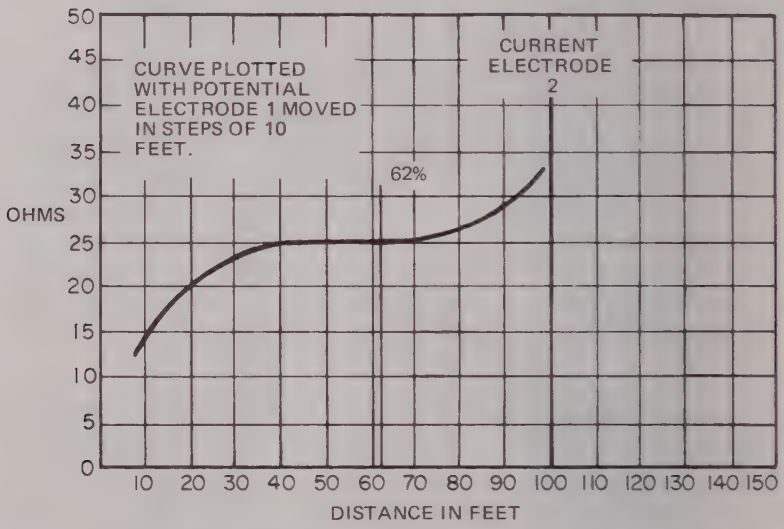


Figure 12. Typical Grounding Resistance Curve to be Recorded and Retained

OPERATING PROCEDURE

1. Establish the proper location for the Auxiliary Current Electrode and Auxiliary Potential Electrode as follows:

   a. Determine the Effective Radius of the equivalent hemisphere in feet for the grounding electrode depth in feet, and the grounding electrode diameter in inches, using the curves in figure 8.

   b. Using this Effective Radius, determine the distances for the Auxiliary Current Electrode No. 2 and Auxiliary Potential Electrode No. 1 from the Ground Electrode, using the data in figure 11.

2. Locate the VIBROGROUND in a suitable location, near the grounding system to be tested.

3. Using a test lead of less than 0.05 ohm resistance, connect VIBRO-GROUND terminal X to the Grounding Electrode or Grounding Grid to be measured, terminal 1 to the auxiliary Potential Electrode, and terminal 2 to the Auxiliary Current Electrode (less than 1 ohm).

4. If the general range of resistance to be measured is anticipated, then set the MULTIPLY BY switch to a multiplying factor within this range. If unknown, select the highest multiplier range first.

5. Operate the TEST switch to the ADJ position. Rotate the OHMS control knob until the galvanometer indicates balance at center scale.

   a. Should the galvanometer indication remain to the right of center scale with the OHMS control at zero, set the MULTIPLY BY switch to the adjacent lower range.

   b. Should the galvanometer indication remain to the left of center scale with the OHMS control fully clockwise, set the MULTIPLY BY switch to the adjacent higher range.

6. After balance is achieved with the TEST switch in the ADJ position, operate this switch to the READ position and rebalance the galvanometer with the OHMS control.

7. Read the resistance on the calibrated OHMS scale. If this indication is less than 1/10 of full range, set the MULTIPLY BY switch to the adjacent lower range and rebalance the galvanometer. (This provides better readability and resolution.)

8. Multiply the OHMS scale indication by the factor indicated by the MULTIPLY BY switch. This product is the resistance of the grounding system connected to terminal X. Record this resistance value.

NOTE

If balance cannot be achieved under any conditions, check the test leads for opens. Make sure that the leads are properly connected (step 3). If the trouble persists, the grounding system may be inadequate due to a high resistance beyond the range of the VIBROGROUND.

9. Move the Auxiliary Potential Electrode 10 feet on each side of the 62% point, as shown by points B and C in figure 10 and repeat steps 4 through 8 for each. Record this resistance value.

10. Compare the resistance values obtained in steps 8 and 9. They should be within the established tolerance band as explained on page 14 and they are the resistance of the grounding system. If they are not within the established tolerance, move the Auxiliary Current and Potential Electrodes to a point further away from the ground under test and repeat steps 3 through 9. Record the resistance values obtained.

MULTIPLE DRIVEN RODS FORMING A LARGE GROUNDING GRID SYSTEM

A single driven rod is an economical and simple means of making a Grounding Electrode. In general, however, a single driven rod does not provide a sufficiently low resistance, and consequently several rods must be driven and connected in parallel by a cable. Although these rods are connected as would be parallel resistances, their total resistance does not follow the usual law for computing resistances in parallel. In order to attain the full effect of resistances in parallel, these rods would have to be spaced at such distances that the Effective Resistance Areas immediately surrounding them would not overlap. The extent to which the areas overlap determines how much of their effectiveness is lost. The curves of figure 13 show a change in resistance for two, four, and eight parallel rods with various spacing.

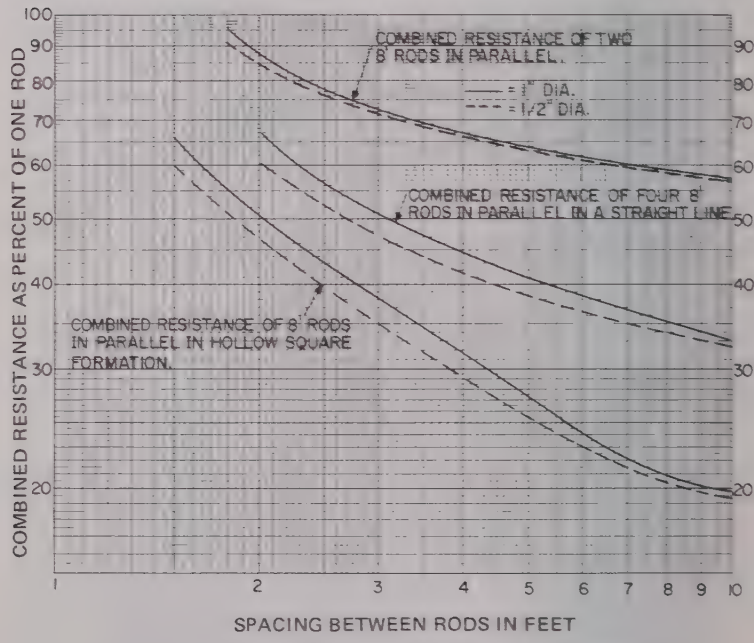


Figure 13. Combined Resistances of Rods in Parallel

When two, three, or perhaps four rods are used in parallel, they are usually driven in a straight line and connected together. In cases where more than four are used, they are usually driven in a hollow square formation and connected in parallel. Distances between the rods are usually made equal as in the hollow square formation of 8 rods shown in figure 14.

Figure 14. Hollow Square Formation of Grounding Electrodes

When measurements are to be made on large formations or on substations contained within a fence that is part of the grounding system, the required distances for the auxiliary electrodes should be based on the diagonal (or longest dimension) of the entire Grounding System. These distances can be determined from figure 15, which is based on the computed hemisphere for various numbers of rods arranged in hollow square formation.

For example, a hollow square formation having 40 foot sides would have a diagonal of about 57 feet. Figure 15 shows that current and potential electrodes should be spaced at about 370 feet and 230 feet, respectively.

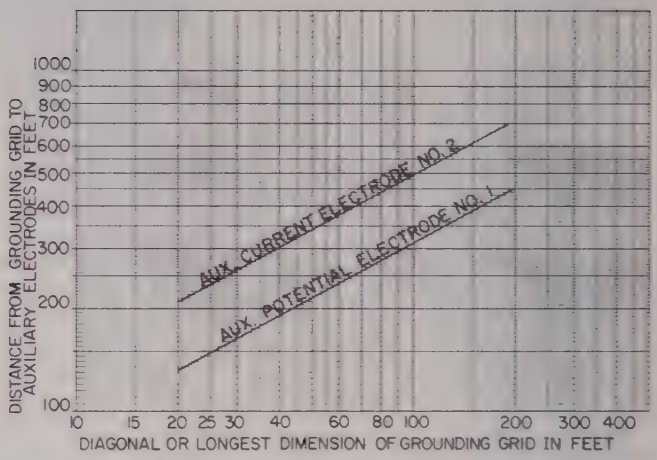


Figure 15. Auxiliary Electrode Distances Versus Longest Grid Dimensions

GENERAL INFORMATION

DIFFICULTIES IN MEASUREMENT

Major difficulties are encountered when measuring large grid systems due to the fact that theory and computations are usually based on homogeneous soil. Non-homogeneities in the soil will effect penetration depth and consequently distort the curve being plotted. In extremely large ground grid systems using several configurations of electrodes, the true center from which to properly space the current and potential electrodes is difficult to determine.

If the electrodes are spaced sufficiently high so that the center is unimportant, several thousand feet may be required and this, of course, becomes impractical.

When measuring resistance of any grounding system, single driven electrodes or grid systems, it must be realized that other common grounding connections will influence total measured resistance. For instance, if a ground grid system consisting of multiple driven rods connected in parallel is in turn connected to a fence surrounding a sub-station, the fence can be considered as being connected in parallel with the grid system. Total resistance measured will be that of the entire grounding system. Whether these grounds can be isolated and measured separately is primarily a matter of regulations, danger involved while they are isolated, and practicality.

ELECTRODE ARRANGEMENTS

The angle at which the electrodes are placed with respect to a Ground Grid system is primarily a matter of choice or requirement, due to surrounding obstructions. However, there are pros and cons as to whether the electrodes should be placed at 90 degrees with respect to the sides of the grid or diagonally from a corner. Many times one placement versus the other has yielded different test results. This may very well be due to homogeneity of the soil of one area versus the other.

Curves have also been plotted with the current electrode on one side of the Grounding Electrode or Ground Grid system, and the potential electrode on the opposite side (180^{o} apart). This arrangement yields a curve similar to that shown in figure 16. This arrangement may give erroneous results since there is no way of checking the presence of errors during the test.

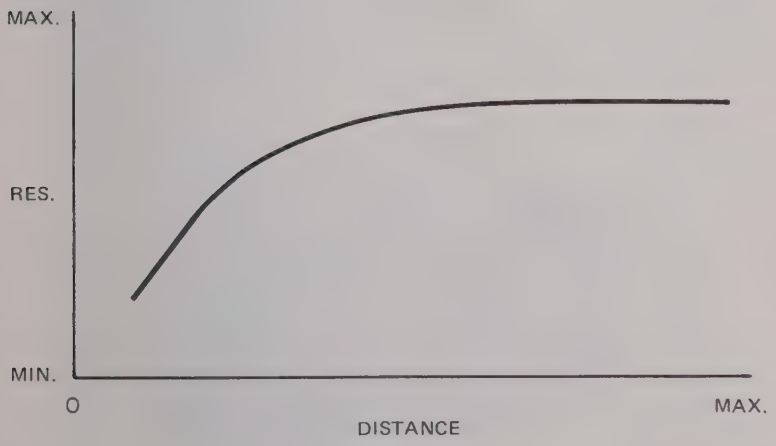


Figure 16. Plotted curve with Current and Potential Electrodes 180^{o}apart

Another method of measuring Ground resistance is the two point method. With this method a reference ground system of known or negligible resistance is used. Here, the resistance of the Grounding Electrode and reference ground system is measured in series. (See figure 17.) The resistance of the known reference ground system is then subtracted from the total resistance indication to yield the resistance of the Grounding Electrode. This method has several objections. One is, that usually resistances of reference ground systems such as water pipes or other structures are unknown. Another is, that should the reference ground resistance be known, it may be excessively high in comparison, thus, the small fraction end result may be very doubtful. Still another is the fact that the reference ground may be extensive and the resistance areas of the reference ground and Grounding Electrode may overlap considerably.

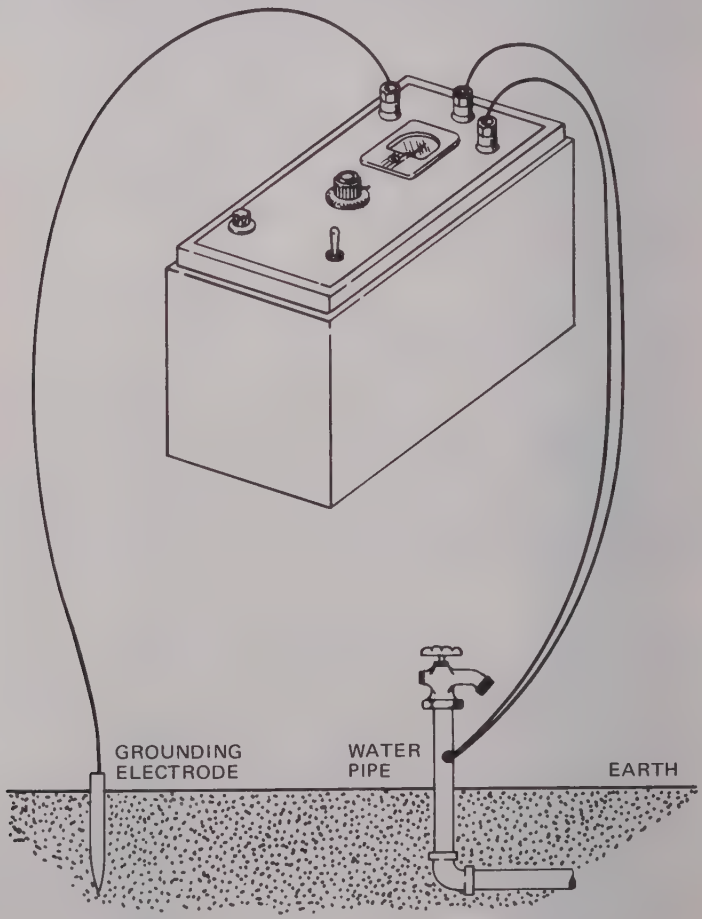


Figure 17. Two Point method of measurement

METER

The pointer on your VIBROGROUND meter should rest directly over the zero (center) mark on the meter scale. If the pointer is not in this position, carefully turn the set screw in the center of the meter cover until the pointer is zeroed.

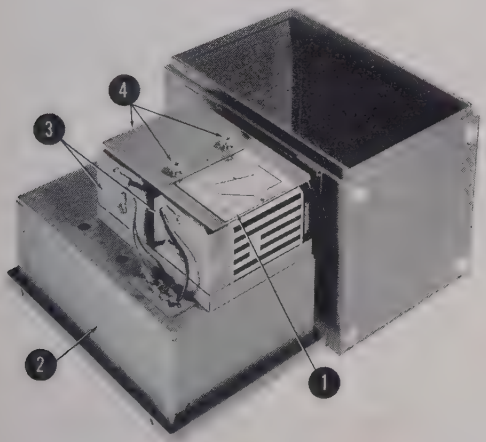
BATTERIES

A noticeable decrease of meter sensitivity when zeroing the meter indicates battery life is almost terminated. When this occurs replace the two 1.5-volt dry cells with fresh Burgess 4FH, Eveready 735, or equivalent batteries.

REPLACING BATTERIES

Remove the four screws (13, figure 1) and lift out the entire assembly as shown in figure 18. Remove the thumb nuts and clamp plate (4), and batteries (3). Disconnect the battery wires and connect them to new batteries; Use the Battery Connection Diagram as a guide.

Replace the batteries, clamp and thumbnuts making certain that the battery terminals are oriented as shown in figure 18. Replace the assembly into the case and secure with the four screws.



1. Battery Connection Diagram
2. Panel with Protective Cover
3. Batteries
4. Battery Clamp with Thumbnuts

Figure 18. Battery Compartment View of the VIBROGROUND

ACCIDENTAL DAMAGE

Despite rugged construction throughout, your VIBROGROUND, and especially the sensitive meter movement should not be subjected to heavy blows, dropping or shocks. However, if your VIBROGROUND requires repair, return it to the factory for prompt, economical repair.

Send it to:

Associated Research, Inc.
3758 West Belmont Avenue
Chicago, Illinois 60618

Pack the instrument carefully in carton or box, with generous proportions of excelsior, paper, or other protective cushioning to prevent damage in transit. For fastest service, ship prepaid by REA or Air Express, insured for full value.

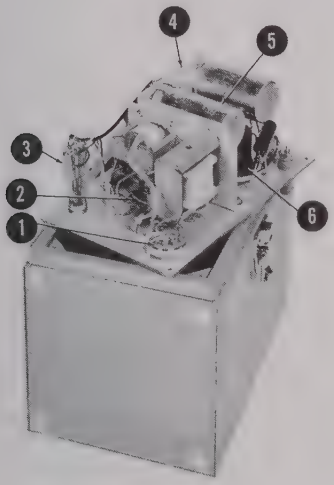
Under separate cover, send letter and/or purchase order to Associated Research Incorporated giving the following information:

1. Model and Serial Number.
2. Defect noted.
3. When and how the instrument was or will be shipped (waybill number if possible).
4. Address to send invoice.
5. Address to return instrument.

All repairs are on a time and material basis, F.O.B. Chicago, Illinois, with terms to credit-approved firms, net 30 days.

REPAIR PARTS

Qualified and properly equipped instrument repair facilities may order parts for field repairs. When ordering replacement parts, be certain to include: Model and serial numbers of the instrument, date purchased, and if possible, return the old part to us with your order. Figure 19 identifies the principle parts and assemblies of the VIBROGROUND.



1. Range Selector Switch
2. Meter Balancing Potentiometer
3. Test Switch
4. Component Chassis Assembly
5. Vibrator
6. Meter

Figure 19. Under Panel View of the VIBROGROUND

GLOSSARY

(Definitions partially extracted from IEEE No. 81)

GROUND	A connection to the earth for conducting electrical current to and from the earth.
GROUNDING ELECTRODE	A conductor imbedded in the earth for maintaining ground potential on conductors connected to it.
GROUND GRID	A system of grounding electrodes interconnected by bare cables buried in the earth to provide lower resistance than a single grounding electrode.
GROUND MAT	A system of bare conductors, on or below the surface of the earth, connected to a ground or ground grid to provide protection from dangerous touch voltage.
GROUND RESISTANCE	The ohmic resistance between a grounding electrode and a remote or reference grounding electrode so spaced that their mutual resistance is essentially zero.
GROUND CURRENT	Current in the earth or grounding connection.
TOUCH VOLTAGE	The potential difference between a grounded metallic structure and a point on the earth's surface equal to the normal maximum horizontal reach. Approximately 3 feet.
STEP VOLTAGE	The potential difference between two points on the earth's surface separated by a distance of one pace, or about 3 feet, in the direction of maximum potential gradient.
RESISTIVITY	Resistance between opposite faces of a unit cube. Expressed in ohm-centimeters or ohms per cubic centimeter.
GROUNDING CONNECTION	A connection used to establish a ground, consisting of a grounding conductor, a grounding electrode, and the earth surrounding the electrode.
AUXILIARY ELECTRODES	Metallic electrodes pushed or driven into the earth to provide electrical contact for the purpose of performing measurements on Grounding Electrodes or Ground Grid Systems.

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vibroground

Warranty

VIBROGROUND instruments are guaranteed free from defects in workmanship and material for one year from date of shipment provided Owner's Registration Card is returned within fifteen days from receipt of unit and there is no evidence of tampering or abuse.

This Warranty does not cover tubes, batteries, or accessories not of our manufacture.

Any unit found defective under this guarantee will be repaired or replaced free of charge if returned to the factory PREPAID and insured.

ASSOCIATED RESEARCH, INC.
3758 W. Belmont Ave., Chicago, Illinois 60618

Instruments for measuring

- Insulation resistance . . . . . the MEG-CHEK®
- Earth resistivity . . . . . the VIBROGROUND®
- Ground resistance. . . . . the VIBROGROUND®
- High voltage breakdown, AC-DC . . . . the HYPOT®
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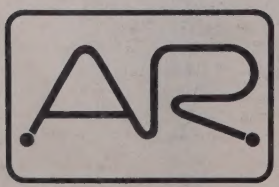

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